EFFECT OF POLYETHYLENE COMPONENT THICKNESS ON STRESSES IN TOTAL ANKLE ARTHROPLASTY

P. Smolinski[a], **K. Galik**[a], **S. Conti**[b] and **M. Miller**[c]

[a]Mechanical EngineeringDepartment
University of Pittsburgh
Pittsburgh, Pennsylvania 15261
patsmol@pitt.edu

[b]Department of Orthopaedic Surgery
University of Pittsburgh
Pittsburgh, PA 15261
Sconti8@attbi.com

[c]School of Health Sciences
Duquesne University
Pittsburgh, PA 52242-1527
millermark@duq.edu

The wear of polyethylene components used in total joint arthroplasty is the limiting factor in the longevity of joint replacement. While the stresses in the polyethylene components used in hip and knee replacement have been studied, little is know about the polyethylene liner stresses in ankle replacement. The large loads that are transmitted through the ankle raise concerns about wear and fracture of polyethylene component. Previous studies for hip arthroplasty have shown that increasing the polyethylene liner thickness has the effect of reducing the von Mises stress and contact pressure. The effect of polyethylene liner thickness on liner stresses has not been studied in the ankle and since the ankle components have a different geometry and loading than the hip, it is not known if results of the hip studies apply to the ankle.

A finite element model was developed of the lower leg and implant components, modeling the Agility™ ankle system (Depuy, Inc.). The implant system consist of a metal tibial tray that supporting a concave cylindrical polyethylene liner that articulates with a convex cylindrical cobalt-chrome talar component. The radius of the polyethylene bearing is 0.8 mm larger than that of the cobalt-chrome component which has a edge radius of 3 mm. Linear elastic material properties were assumed for all bone and metal components and the polyethylene was modeled as an elastic-plastic material. A total load of five times body weight was applied to the proximal tibia and fibula with the fibula carrying 7% of the load.

The thickness of the polyethylene component in the prosthesis was varied and the effect on contact pressure and von Mises stress was examined. The thickness was increased in 1 mm increments starting with the standard minimum of 3 mm up to 8 mm, while other geometry of the other components was unchanged. The results showed that the contact pressure at the center of the cylindrical implant decreased only slightly with increasing thickness. The von Mises stress at this location increased slightly with thickness. The greatest stresses occurred at the contact with the 3 mm diameter edge, and both the contact pressure and the von Mises stress increased with increasing thickness. These results indicate that increased polyethylene liner thickness may not be beneficial for all joint replacements.